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ORIGINAL ARTICLE

Immediate continuous positive airway pressure (CPAP) therapy after sleeve gastrectomy

Asem A. Hewidy [a,*], Lucy A. Suliman [a], Emad El Hefnawy [b], Adel Ali Hassan [c]

[a] *Chest Medicine Department, Mansoura University, Egypt*
[b] *Anesthesia and Intesive Care Unit, Gastroenterology Center, Mansoura University, Egypt*
[c] *Anesthesia and Intensive Care Unit, Liver Research Institute, Mansoura, Egypt*

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KEYWORDS

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Abstract Noninvasive continuous positive airway pressure ventilation may improve postoperative oxygenation, lung functions and reduce postoperative complications in morbidly obese patients undergoing sleeve gastrectomy.

Aim: Evaluation of the effect of immediate postoperative CPAP therapy after sleeve gastrectomy in improving oxygenation, pulmonary functions values, reducing atelectasis and reducing postoperative pulmonary complications.

Patients and methods: Single blind randomized clinical trial, was conducted in Gastroenterology Centre and Chest Department, Mansoura University Hospitals during the period from 2013 to 2015 on 46 morbidly obese patients after sleeve gastrectomy. Patients were divided into two groups; group (A) immediately placed on CPAP (8–12 cm H_2O) for at least 8 h and group (B) control group, received oxygen support 4–6 L per minute via nasal catheter. The primary end points of the study were CXR, spirometric pulmonary function (FEV1, FVC, FEV1/FVC) and O_2 tension and saturation measured 24 h postoperatively and the secondary endpoints were postoperative pulmonary complications during the first 2 weeks.

Results: As regards FEV1 and FVC, there was a high statistically significant difference between both groups after treatment and there was a statistically significant increase in group (A) after treatment versus before treatment. As regards oxygen tension and saturation there were high statistically significant differences between both groups after treatment. There was a statistically significant decrease in atelectasis in group (A). There were statistically significant differences between both groups as regards postoperative respiratory failure and persistent atelectasis but there were no statistically significant differences in pneumonia and gastric distension.

Conclusion: The use of immediate CPAP after sleeve gastrectomy in morbidly obese patients is effective in improving oxygenation, spirometric values, reducing atelectasis and decreasing postoperative pulmonary complications.

* Corresponding author.
E-mail address: ahewidy@yahoo.com (A.A. Hewidy).

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Introduction

Morbidly obese patients are at an increased risk for postoperative pulmonary complications such as atelectasis due to loss of functional residual capacity, anesthesia, and surgery, and upper airway obstruction due to obstructive sleep apnea syndrome (OSA), anesthesia, and opioid analgesia [1].

Obstructive sleep apnea may be present in up to 80% of bariatric patients. The presence of OSA can increase the occurrence of postoperative pulmonary complications [2]. Noninvasive ventilation devices such as continuous positive airway pressure (CPAP) and bi-level positive airway pressure (BiPAP) can be used to reduce the incidence of postoperative pulmonary complications in obese patients undergoing bariatric surgery [3].

The immediate period after tracheal extubation is a hazardous period because of the risks of airway obstruction, narcosis, residual anesthesia, and residual neuromuscular blockade [4]. The maintenance of positive airway pressure immediately post extubation may result in a significant improvement in spirometric lung functions [5].

The aim of our study was to evaluate the effect of immediate postoperative CPAP therapy after sleeve gastrectomy in improving oxygenation, pulmonary function values, reducing atelectasis and reducing postoperative pulmonary complications.

Study design

Single blind randomized clinical trial in which morbidly obese patients decided to do sleeve gastrectomy were divided into two groups, the first group (CPAP group) were extubated and immediately placed on CPAP (8–12 cm H_2O) for at least 8 h on the first postoperative day and the second group (oxygen group) received oxygen support after the extubation, with a flow of 4–6 L per minute via a nasal catheter. The primary end points of the study were chest X-ray, spirometric pulmonary function tests (FEV1, FVC, and FEV1/FVC) and O_2 tension and O_2 saturation measured 24 h postoperatively and the secondary endpoints were postoperative pulmonary complications during the first 2 weeks. The patients were randomly selected using the closed envelop method.

Patients and methods

This study was conducted in Gastroenterology Centre and Chest Department, Mansoura University Hospitals during the period from 2013 April to 2015 October on 46 morbidly obese patients who decided to do sleeve gastrectomy, with the following inclusion criteria: BMI > 40, age 18–65 years, presence of obesity for at least 3 years without hormonal problems, failure to lose weight for at least 1 year despite drug and dietary therapies, can understand the operation and postoperative requirements and complications. Patients with chronic or acute pulmonary disease were not included, and neither who needed invasive mechanical ventilation at the end of the surgery.

Patients were randomly divided into two groups, group A (CPAP group); patients were extubated and immediately placed on CPAP via a portable CPAP (S9, RESMED) 8–12 cm H_2O for at least 8 h on the first postoperative day with a full facemask. Group B (oxygen group); patients received oxygen support after the extubation, with a flow of 4–6 L per minute via a nasal catheter as advised in the hospital protocol. Local ethical approval had been obtained. Patients signed their written consents after detailed explanation of the study protocol.

All included patients were subjected to the following:

One day before operation

Complete medical history and clinical examination.

Routine investigations were done (CBC, liver function tests, random blood glucose, serum creatinine and coagulation profile).

Thyroid profile and serum cortisol.

ECG, chest X-ray and echocardiography.

Spirometric pulmonary function tests (FEV1, FVC and FEV1/FVC were done preoperatively and 24 h postoperatively), three spirometric attempts were measured, and the best value was recorded preoperatively and 24 h postoperatively via portable spirometry (MIR. spirolabII, Italy).

Body mass index (BMI) and ideal body weight (IBW) were calculated and enlisted in the patient's file as follow:

$$\text{BMI} = \text{body weight(in kg)}/\text{height}^2\text{(in meters)}$$

$$\text{IBW} = \text{for men} = 50 + 0.91\{(\text{height in cm-152.4})\}$$

$$\text{For women} = 45.5 + 0.91\{(\text{height in cm-152.4})\}$$

In the morning of the operation at recovery room

After an overnight fasting, the patients were transferred to the operating room and 20-gauge IV cannula was placed. Midazolam 0.03 mg/kg was given I.V to alleviate anxiety. Patients placed in semi sitting position, monitored for ECG, blood pressure and oxygen saturation.

Induction of anesthesia

After five minutes of preoxygenation all patients were induced with fentanyl 1–1.5 μg/kg and propofol 1.5–2 mg/kg (TBW) till loss of verbal contact with patients. Endotracheal intubation was facilitated by succinylcholine 1–1.5 mg/kg (TBW), position of the tube was confirmed by capnography and auscultation. All patients were mechanically ventilated through closed circuit with FGF around 2 L/m, using ventilator (GE Datex-Ohmeda Aisys (USA) ventilator) with initial settings (tidal volume 6–8 ml/kg of ideal body weight, respiratory rate 12–16 BPM, I:E 1:2, PEEP 5–7 cm H_2O, FiO_2 0.4). Ventilatory parameters were modified to maintain Et CO_2 between 30 and 35 mmHg. Before starting surgery radial artery catheter, nasogastric tube, and silicon Foley catheter were inserted. Intra operative monitoring was achieved by 5 lead ECG, pulse oximetry and blood pressure.

Recovery and extubation

After termination of the surgery, discontinuation of the anesthesia and reversal of muscle relaxant was prepared and given to the patients in the form of atropine (0.03 mg/kg) and neostigmine (0.06 mg/kg). Extubation was done after fulfillment of the extubation criteria (e.g.: eye opening, following commands, sustained head lift, full recovery from muscle relaxation: spontaneous breathing with good tidal volume and normocapnia).

Postoperative care unit

In postoperative care unit all patients were nursed in semisitting or sitting position. All patients were followed up by basic vital signs, oxygen supplementation through nasal canula was given in all patients however CPAP device was placed to group (A) only immediately post extubation. NSAIDs were preferred for postoperative analgesia in the form of ketorolac (30 mg) if not sufficient morphine 0.1–0.2 mg /kg of adjusted body weight was given. All patients remain for at least two hours in the postoperative care unit then are transferred to the ward after fulfillment of discharge criteria using modified Aldert's score [6] equal or more than 9.

Statistical analysis

Data were analyzed using SPSS (Statistical Package for Social Sciences) version 15. Qualitative data were presented as number and percent. Comparison between groups was done by Chi-Square test. Quantitative data were presented as mean ± SD. Paired *t*-test was used for comparison within groups. Student's *t*-test was used to compare between two groups. Non parametric data were presented as min–max and median. Mann–Whitney test was used for comparison between groups. The Wilcoxon signed ranks test was used for comparison within group. $P \leqslant 0.05$ was considered to be statistically significant.

Results

Group A: Included 24 patients (7 males and 17 females) with a mean age of 31.25 ± 10.36; these patients were extubated and immediately placed on CPAP via a portable CPAP (S9, RESMED) 8–12 cm H_2O for at least 8 h on the first postoperative day with a full facemask.

Group B: Included 22 patients (10 males and 12 females) with a mean age of 26.86 ± 5.90; these patients received oxygen support after extubation, with a flow of 4–6 L per minute via a nasal catheter as a control group.

There were no statistically significant differences between both groups as regards body mass index and neck circumference before treatment as shown in Table 1.

Table 2 showed that there were no statistically significant differences between both groups as regards FEV1 and FVC preoperatively. As regards FEV1 there was a high statistically significant increase in group (A) than group (B) after 24 h postoperatively ($P < 0.001$), and there was a statistically significant increase in group (A) after 24 h postoperatively versus preoperatively ($P = 0.005$). As regards FVC there was a high statistically significant increase in group (A) than group (B) after 24 h postoperatively ($P < 0.001$), and there was a statistically significant increase in group (A) after 24 h postoperatively versus preoperatively ($P = 0.004$).

Table 3 showed that there were no statistically significant differences between both groups as regards oxygen tension or saturation preoperatively. As regard oxygen saturation there was a statistically significant increase in group (A) than group (B) after 24 h postoperatively ($P < 0.001$), and there was a statistically significant increase in both groups (A) and (B) after 24 h postoperatively versus preoperatively ($P < 0.001$, $P = 0.012$ respectively). As regards oxygen tension there was a statistically significant increase in group (A)

Table 1 Demographic data and anthropometric measurement of the included patients.

	Group A CPAP group ($n = 24$)	Group B oxygen group ($n = 22$)	t	P
Age	31.25 ± 10.36	26.86 ± 5.90	1.783	0.083
Sex				
Male	7 (29.2%)	12 (54.5%)	3.049	0.081
Female	17 (70.8%)	10 (45.5%)		
BMI	58.89 ± 9.46	55.89 ± 8.09	1.151	0.256
Neck circumference	41.17 ± 2.32	40.00 ± 2.27	1.724	0.092

Significant $P \leqslant 0.05$.

Table 2 Pulmonary function tests of the included patients preoperatively and after 24 h postoperatively.

	Group A CPAP group ($n = 24$)	Group B oxygen group ($n = 22$)	t	P
FEV1 before	83.50 ± 18.28	75.32 ± 8.60	1.968	0.057
FEV1 after	93.50 ± 15.07	72.41 ± 8.82	5.722	<0.001*
P (before vs. after)	0.005*	0.243		
FVC before	83.08 ± 17.80	73.64 ± 14.89	1.943	0.058
FVC after	93.29 ± 15.69	64.55 ± 13.16	6.697	<0.001*
P (before vs. after)	0.004*	0.054		

* Significant $P \leqslant 0.05$.

Table 3 Arterial blood gases of the included patients preoperatively and after 24 h postoperatively.

	Group A CPAP group ($n = 24$)	Group B oxygen group ($n = 22$)	t	P
SaO_2 before	90.83 ± 2.18	90.23 ± 2.25	0.928	0.358
SaO_2 after	93.25 ± 2.15	91.14 ± 1.70	3.675	< 0.001*
P (before vs. after)	< 0.001*	0.012*		
PaO_2 before	62.29 ± 5.42	61.05 ± 3.37	0.945	0.351
PaO_2 after	78.83 ± 8.31	63.27 ± 6.33	7.094	< 0.001*
P (before vs. after)	< 0.001*	0.049*		

* Significant $P \leqslant 0.05$.

Table 4 Atelectasis in chest X-ray of the included patients preoperatively and after 24 h postoperatively.

	Group A CPAP group ($n = 24$)		Group B oxygen group ($n = 22$)		χ^2	P value
	No	%	No	%		
Atelectasis before	16	66.7	13	59.1	0.283	0.410
Atelectasis after	6	25.0	11	50.0	3.079	0.073
P (before vs. after)	0.002*		0.414			

* Significant $P \leqslant 0.05$.

Table 5 Postoperative complications of the included patients after 2 weeks.

	Group A CPAP group ($n = 24$)		Group B oxygen group ($n = 22$)		χ^2	P value
	No	%	No	%		
Pneumonia	1	4.2	2	9.1	9.1%	0.457
Respiratory failure	0	0	4	18.2	4.779	0.029*
Persistent atelectasis	2	8.3	7	31.8	4.023	0.045*
Gastric distension	2	8.3	2	9.1	0.008	0.927

* Significant $P \leqslant 0.05$.

than group (B) after 24 h postoperatively ($P < 0.001$), and there was a statistically significant increase in both groups (A) and (B) after 24 h postoperatively versus preoperatively ($P < 0.001$, $P = 0.049$ respectively). The changes in values were few but statistically significant due to low values of standard deviation.

Table 4 showed that there were no statistically significant differences between both groups as regards atelectasis preoperatively. In group (A) there was a statistically significant decrease in the number of patients who had atelectasis after 24 h postoperatively versus preoperatively ($P = 0.002$).

Table 5 showed that as regards postoperative complications pneumonia developed in one patient in group (A) and 2 patients in group (B) and improved with antibiotic treatment. Respiratory failure developed in 4 patients of group (B) and one patient only needed invasive mechanical ventilation and weaned successfully and there was a statistically significant difference between group (A) and group (B). Persistent atelectasis was present in 2 patients of group (A) and 7 patients of group (B) and there was a statistically significant difference between group (A) and group (B). Gastric distension was present in 2 patients of group (A) and (B) and there was no statistically significant difference between group (A) and (B). There was no procedure related mortality.

Discussion

Morbid obesity causes hazards to lung functions due to its effects on mechanical ventilation, airway resistance, lung volumes and respiratory muscles [7]. Also morbid obesity is associated with dramatically increased chest wall elastance, so that, these patients have more chance to develop atelectasis than patients who are non-obese, so noninvasive positive pressure ventilation (NIPPV) is widely recommended to reduce the risk of postoperative complications [8].

The aim of our study was to evaluate the effect of immediate postoperative CPAP therapy after sleeve gastrectomy in improving oxygenation, pulmonary functions values, reducing atelectasis and reducing postoperative pulmonary complications.

As regards FEV1 and FVC there was a high statistically significant increase in group (A) than group (B) after 24 h postoperatively, and there was a statistically significant increase in group (A) after 24 h postoperatively versus preoperatively. These results were similar to Ebeo et al. [9] who evaluated the effect of BiPAP on pulmonary functions in obese patients after open gastric bypass surgery. Twenty-seven patients were included: 14 received BiPAP and 13 received conventional postoperative care. FVC and FEV1 were significantly higher on each of the 3 consecutive postoperative days in the patients who received BiPAP therapy. And also near to Joris et al. [10] who used BiPAP during 12–24 h, in periods from 3 to 4 h. They observed an increase in the FVC and FEV1 from 24% to 30% in the group that used NIV in comparison to the control group during the measurement of the pulmonary function in the postoperative period. Our results were similar to these studies as we targeted similar patient group and managed them by CPAP therapy in postoperative period which gave us near similar results to BiPAP therapy to their patients.

In our study, both oxygen saturation and tension were statistically significantly higher in group (A) versus group (B) after 24 h postoperatively ($P < 0.001$, $P < 0.001$ respectively), also there was a statistically significantly higher oxygen saturation in both groups (A) and (B) after 24 h postoperatively versus preoperatively ($P < 0.001$, $P = 0.012$ respectively). Oxygen tension also was statistically significantly higher in both groups (A) and (B) after 24 h postoperatively versus preoperatively ($P < 0.001$, $P = 0.049$ respectively). This can be explained by the use of CPAP that restores the functional residual capacity (FRC) to preoperative levels, improving postoperative oxygenation [11]. Our results were in accordance to Chalhoub et al. [12] who studied non invasive ventilation (NIV) in morbidly obese patients undergoing open bariatric surgery and they found that patients who used NIV demonstrated an increase in PaO_2 and SaO_2 during the postoperative period than those who did not use NIV. This indicates better oxygenation levels with the use of NIV.

As regards atelectasis, in group (A) there was a statistically significant decrease in atelectasis after 24 h postoperatively versus preoperatively ($P = 0.002$) but in group (B) there was no statistically significant decrease, so CPAP treatment significantly decreases atelectasis postoperatively and this is a good effect of CPAP as we know that atelectasis actually worsens in patients who are morbidly obese over the first 24 postoperative hours. Loss of FRC, lung derecruitment, airway closure, and airway obstruction predispose patients to hypoxemia [5]. High inspired concentrations of oxygen increase the extent of absorption atelectasis and reduce FRC further [13]. These competing problems can be offset by the application of CPAP during oxygen administration [14], and postoperatively [15]. Our results were comparable to Ahmad et al., who found that the NIV has been successfully used to correct atelectasis in the postoperative period and thus restores the FRC, prevents the collapse of upper airways and increases the lung compliance [16].

Postoperative complications were lower in group (A) than group (B) as regards pneumonia but statistically insignificant, there were statistically significant differences between both groups as regards respiratory failure and persistent atelectasis, and there was no difference between both groups as regards gastric distension and there was no procedure related mortality. Our results were lower than those reported by Squadrone et al. who studied 209 patients who were hypoxemic after major abdominal surgery and randomized them to receive CPAP or standard oxygen therapy. CPAP was associated with a significant reduction in infectious complications and reintubation, and a shorter duration of intensive care unit stay as they studied larger number of patients with more comorbidities and more major abdominal surgery [17]. Substantial aerophagia leading to pouch distension does not occur routinely during postoperative use of CPAP in patients after laparoscopic bariatric surgery [18] and this was similar to our results regarding gastric distension.

Conclusion

The use of CPAP in the postoperative period of sleeve gastrectomy in morbidly obese patients is effective in improving oxygenation, spirometric values, reducing atelectasis and decreasing postoperative pulmonary complications.

Conflict of interest

There is no conflict of interest.

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